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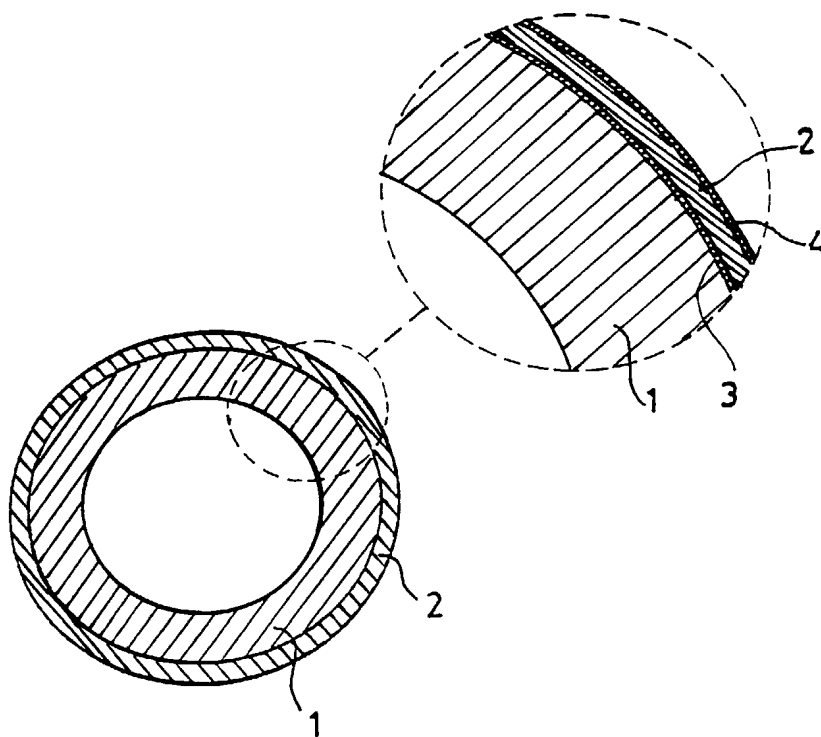
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(54) Title: PLASTIC PIPE WITH A BARRIER LAYER



(57) Abstract: A plastic pipe (1) is provided with a barrier layer (2) which is applied to its outer side and is less than 1 μm , preferably less than 0.1 μm , thick. The barrier layer (2) consists of metal, preferably aluminium. The metal layer (2) is applied to the plastic pipe by physical vapour deposition under high vacuum, the plastic pipe (1) being smoothed on the outer side before the layer of metal (2) is applied.



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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

PLASTIC PIPE WITH A BARRIER LAYER

The invention relates to a plastic pipe with a barrier layer
5 applied to its outer side.

Plastic pipes as such are not completely impermeable to all
media in all situations. In particular, pipes made from
polyolefins, such as polyethylene and polypropylene, to a
10 certain extent allow substances such as oxygen and certain
organic substances to pass through. This may cause problems.
When using plastic pipes for indoor heating purposes, oxygen may
diffuse inwards through the pipe wall and may then affect the
metal components of the heating system. When using plastic pipes
15 as outdoor water pipes in ground which is contaminated with
organic substances, these substances may have an adverse effect
on the quality of the water in the pipe.

Therefore, it is proposed for the plastic pipes for such
20 applications to be provided with a barrier layer, in particular
a layer of metal, which is completely resistant to diffusion, on
the outer side.

Known methods for applying the layer of metal are, for example,
25 winding a metal foil around the plastic pipe or forming a
thin-walled metal pipe and applying a layer of plastic to the
inner side and/or the outer side by extrusion. However, the
thickness of the layer of metal applied in this way is much
greater than is necessary for a good barrier action.

30 It is known from DE-U-298 22 212 to apply a thin barrier layer
of silicon oxide with a thickness of a few nm to μm to a plastic
pipe by means of physical deposition under high vacuum. However,
it has been found that pipes of this type have an inadequate
35 barrier action.

It is an object of the invention to provide an improved plastic
pipe with a barrier layer applied to the outer side.

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According to the invention, this object is achieved by means of a plastic pipe according to claim 1.

5 Tests have shown that the barrier layer is not completely impervious when the outer surface of the plastic pipe is in its usual state and has the usual roughness. Although when looked at normally the outer surface appears to be smooth, on a microscale there is nevertheless considerable unevenness which, when a very thin layer of metal is being applied, as is the case here, leads to interruptions in the barrier layer, with the result that the barrier layer is not completely impermeable.

15 The plastic pipe according to the invention has the desired barrier action with a minimal thickness of the barrier layer.

The invention also relates to a method for the manufacture of a plastic pipe according to claim 11.

20 This method enables a very thin diffusion-resistant metal layer to be applied to a plastic pipe.

Preferred embodiments of the plastic pipe and the method according to the invention are defined in the dependent claims.

25 The invention will be explained in more detail with reference to the drawing, in which the only figure shows a cross section through a plastic pipe according to the invention.

30 The drawing shows a cross section through a plastic pipe 1 which is provided on its outer side with a thin barrier layer, such as a layer of metal 2. A plastic pipe of this type is used, for example, indoors in heating installations or outdoors as a water pipe in ground which is contaminated with organic substances. The layer of metal provides the plastic pipe with the desired barrier properties.

The plastic pipe 1 is manufactured, for example, from a polyolefin, such as polyethylene, polypropylene or polybutylene.

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According to the invention, the barrier layer 2 is less than 1 μm , preferably less than 0.1 μm , thick and preferably consists of aluminium, an aluminium alloy or aluminium oxide. As an alternative to aluminium, it is also possible to consider other metals, such as copper and zinc. If appropriate, it would also be possible to use other materials, such as silicon oxide.

In the text which follows, it will be assumed that a layer of metal is used as the barrier layer.

10

The layer of metal 2 is applied to the plastic pipe 1 by physical vapour deposition under high vacuum, a technique which is known per se.

15 To achieve good adhesion between the very thin metal layer 2 and the plastic pipe 1 and/or a diffusion-resistant layer 2, the outer surface of the plastic pipe 1 is smoothed prior to the physical vapour deposition. The smoothing is preferably effected by the application of a layer of lacquer, by extrusion or by spraying. The thickness of the layer of lacquer is preferably 10 μm .

On the outer side, the metal layer is preferably provided with a protective layer 4, which may consist of the same material as the plastic pipe 1. This protective layer 4 is used in particular to prevent mechanical damage to the very thin layer of metal 2, but also to prevent excess oxidation of this layer. The protective layer may also be provided with certain additives, such as dyes or UV shields, or may be printed. This allows the plastic pipe to be made more suitable for a specific purpose.

The protective layer on the outer side may also consist of a layer of lacquer which is similar to or of the same type as the layer of lacquer between pipe and layer of metal. It has been found that the thin external layer of lacquer also improves the barrier action by preventing mechanical damage to the layer of metal.

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A combination of firstly a layer of lacquer and then a layer of plastic provides even better results.

5 The layer of metal may be applied to the plastic pipe 1 either continuously or discontinuously.

10 In the continuous method of application, the plastic pipe 1 is successively extruded, smoothed on the outer side, brought to the required high vacuum in a number of steps in successive vacuum chambers with a continuously increasing vacuum, and provided with a layer of metal 2, such as a layer of aluminium, by physical vapour deposition under high vacuum. In the same process, a protective layer 4 is also applied to the outer side of the layer of metal 2 by means of in-line extrusion.

15 If, as appears possible, the linear speed of the equipment for the physical vapour deposition of the layer of metal is higher than that of the production machines for the pipe, it is obviously also possible for the inherently continuous method to be carried out in separate parts. First of all the pipe is extruded, optionally provided with a smooth outer layer and coiled.

20 Then, existing coils, if appropriate from a plurality of pipe production machines, can be uncoiled and successively passed through the vapour deposition equipment in a continuous process, optionally after first being provided with a smooth outer layer. This makes it easier to optimally adapt the different capacities to one another.

30 In the discontinuous application method, the plastic pipe 1 is extruded and provided with a layer of lacquer on the outer side in a continuous process, and a certain length of the pipe 1 formed in this way is coiled, for example on a coiler. Then, the coiled pipe 1 is placed under a high vacuum, is uncoiled, is provided with a layer of metal 2 by physical vapour deposition under high vacuum and is coiled again. In a following step, it is also possible to apply a protective layer 4 to the outer side

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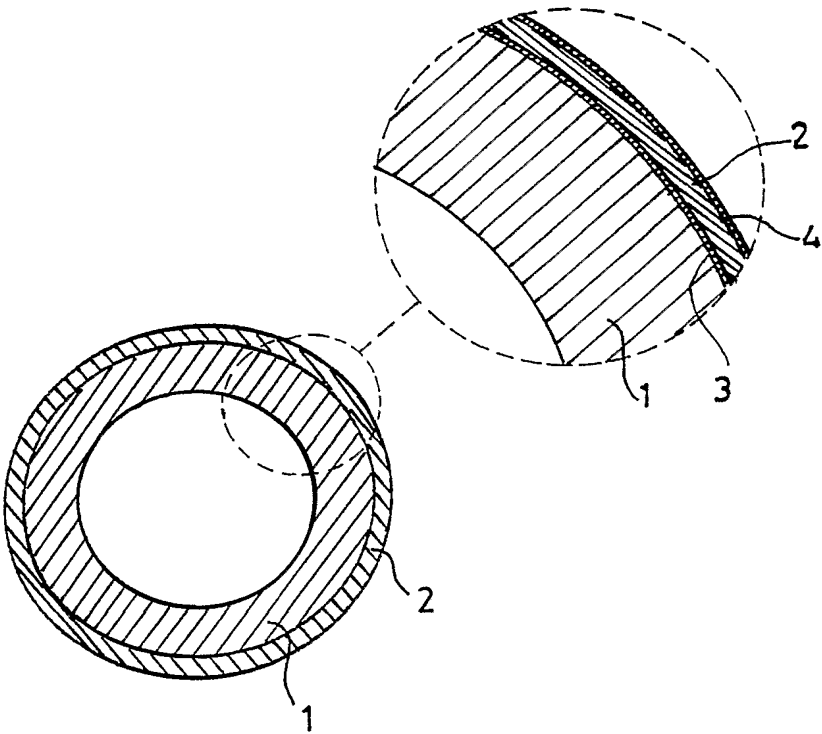
of the layer of metal 2, which protective layer may comprise a layer of lacquer and/or a layer of plastic.

5 Although the discontinuous method of application appears time-consuming, it is a simpler design, since the necessary sealing of the successive vacuum chambers through which the plastic pipe 1 provided with a layer of metal 2 has to pass is not easy to achieve without damaging the metal layer 2.

CLAIMS

1. Plastic pipe with a barrier layer applied to its outer side, the thickness of the barrier layer being less than 1 μm , and a smooth interlayer being present between the plastic pipe and the barrier layer.
2. Plastic pipe according to claim 1, in which the plastic pipe is manufactured from a thermoplastic.
3. Plastic pipe according to claim 1 or 2, in which the interlayer is a layer of lacquer.
4. Plastic pipe according to one of claims 1-3, in which the barrier layer on the outer side is provided with a protective layer.
5. Plastic pipe according to claim 4, in which the protective layer is a layer of lacquer.
6. Plastic pipe according to claim 4, in which the protective layer is a layer of plastic.
7. Plastic pipe according to claim 4, in which the protective layer comprises, from the inside outwards, a layer of lacquer and a layer of plastic.
8. Plastic pipe according to claim 7 or 8, in which the layer of plastic consists of the same material as the plastic pipe.
9. Plastic pipe according to one of claims 1-8, in which the barrier layer comprises a layer of metal.
10. Plastic pipe according to claim 9, in which the layer of metal consists of aluminium, an aluminium alloy or aluminium oxide.

11. Method for the manufacture of a plastic pipe with a metal layer applied to its outer side, which is applied by physical vapour deposition under high vacuum, the outer side of the plastic pipe being smoothed by the application of a layer of lacquer before the layer of metal is applied.
12. Method according to claim 11, in which the layer of lacquer is applied in a continuous process.
13. Method according to claim 12, in which the layer of lacquer is applied by extrusion.
14. Method according to claim 12, in which the layer of lacquer is applied by spraying.
15. Method according to one of claims 11-14, in which the layer of metal is provided with a protective layer on the outer side.
16. Method according to one of claims 11-15, in which the plastic pipe is successively extruded, smoothed on the outer side, brought to the desired high vacuum in a number of steps in successive vacuum chambers with a continuously increasing vacuum, and provided with a layer of metal by physical vapour deposition under high vacuum.
17. Method according to claim 16, in which, after the layer of metal has been applied, it is provided on the outer side with a protective layer by means of in-line extrusion.
18. Method according to one of claims 11-16, in which the plastic pipe is extruded and is smoothed on the outer side, a certain length of the plastic pipe is coiled, is placed under high vacuum in the coiled state and is uncoiled again, is provided with a layer of metal by physical vapour deposition under high vacuum and is coiled again.



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International Application No

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F24D3/14 C23C14/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 F24D C23C F16L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 298 22 212 U (HEWING GMBH) 18 March 1999 (1999-03-18) page 4, line 31 -page 4, line 33 ---	1, 9, 11, 16
X	US 4 131 530 A (BLUM PETER ET AL) 26 December 1978 (1978-12-26) the whole document ---	11, 15
A	US 5 685 961 A (BOXMAN RAYMOND LEON ET AL) 11 November 1997 (1997-11-11) abstract ---	11
A	DE 33 20 273 A (BECKER PRUENTE GMBH) 6 December 1984 (1984-12-06) cited in the application abstract --- -/-	1, 11, 16



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

* Special categories of cited documents :

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- *O* document referring to an oral disclosure, use, exhibition or other means
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- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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- *Z* document member of the same patent family

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/NL 01/00473

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>DE 296 07 324 U (HEWING GMBH) 21 August 1997 (1997-08-21) the whole document -----</p>	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/NL 01/00473

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